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THE PRODUCTION OF CUCUMBERS IN GREENHOUSES

GREENHOUSE CUCUMBERS are one of the three most important vegetable crops grown in forcing houses. Large quantities are produced in the forcing ranges around Boston, Mass., Rochester, N. Y., Ashtabula, Cleveland, and Toledo, Ohio, Chicago, Ill., and other points. Lettuce, cucumbers, and tomatoes make up the bulk of the vegetable forcing crop of the United States, according to the 1929 census, being worth about $8,000,000 per annum.

Cucumbers deteriorate rapidly after they are removed from the plant, but those that are properly grown in greenhouses near the market can be placed in the hands of the consumer in a fresh, crisp condition.

Success depends on the kind of greenhouse used, the availability of cheap fuel and labor, ready access to suitable markets, and close attention to details. Cucumber forcing is a highly specialized form of work, but under favorable conditions the industry is profitable.

There is an increasing demand for cucumbers of the quality that can be grown in greenhouses and delivered to the consumer in a fresh state, and it would seem that there is room for a considerable expansion of the industry.

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THE PRODUCTION OF CUCUMBERS IN GREENHOUSES

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GREENHOUSE-GROWN CUCUMBERS

GREENHOUSE-GROWN CUCUMBERS occupy a high place in the estimation of those who have learned to appreciate their superior quality. While the cucumber is not high in food value, it is extremely popular, owing to the fact that it is an appetizer with a sprightly flavor which appeals to most palates. It can be served with various dressings and is much used as an ingredient of salads. The development of the vegetable-forcing industry in this country was largely influenced by the winter demand for cucumbers, lettuce, and tomatoes; and these have always been the most important vegetable-forcing crops produced in the various sections of the United States. According to available records, cucumbers are second in importance, with tomatoes occupying first place. These crops represent at least 90 percent of the $8,000,000 annual value of the vegetable-forcing crops produced in this country.

LOCATION AND GROWTH OF THE INDUSTRY

Vegetable forcing in the United States had its pioneer development in the section near Boston, Mass. This was quickly followed by the erection of extensive ranges of forcing houses at Grand Rapids, Mich. Subsequently the industry developed in such centers as Rochester, N. Y.; northern Ohio, including Cleveland, Ashtabula, and Toledo; Chicago, Ill.; and many other places. While the industry is centralized in the places mentioned, it is by no means confined to these areas, as vegetable-forcing ranges are to be found

in nearly all sections of the country. Wherever the growing of greenhouse vegetables is carried on, cucumbers usually constitute an important part of the product.

Many factors have influenced the growth of the vegetable-forcing industry in the sections where it has attained considerable importance. The modern forcing house makes it possible to produce a high-grade product over a wide range of seasons and to put it on the market within a few hours after it is harvested. Cucumbers grown in this manner can be carried to the proper stage of maturity on the vines and put in the hands of the consumer in a perfectly fresh state. Few vegetables lose more in quality by not being served perfectly fresh than does the cucumber. The use of the forcing house makes it possible to mature the crop at seasons when the outdoor-grown product is not available. Moreover, it is possible to grow greenhouse cucumbers so that they can be marketed in competition with much of the outdoor-grown crop produced in the winter-gardening sections of the country, which must bear an exceedingly high transportation and handling cost before it reaches the consumer.

Vegetable forcing in the United States is not an old industry, and many of the existing establishments were located without much consideration of the factors affecting the economical production of vegetable crops. In many cases the greenhouses have been built where they now are simply because some one with an interest in such work undertook it in his locality. It should be borne in mind that success in this industry is largely influenced by such factors as suitable equipment, cheap fuel, quick access to markets, a sufficient supply of labor, soil suitable for the crops, and an abundance of water. A supply of stable manure is essential, and if this cannot be secured from a nearby city, provision should be made to obtain it from a dairy or stock farm so located that expensive hauling charges can be avoided. The weight of cucumbers is relatively greater than that of the other important forcing vegetables, and in establishing a range where cucumbers are to be the main crop it is important that the location be as near the markets as practicable, on account of transportation costs. It would seem that the grower who produces a high-quality product and puts it on the market in a fresh condition at a price which makes a profit possible has an excellent chance to make a success of the greenhouse-cucumber business.

SUITABLE GREENHOUSES

No important vegetable-forcing crop is more sensitive to the conditions under which it is grown than the cucumber, and success in the production of the crop is largely dependent on having houses suited to its requirements. The type of house best suited to cucumber growing is one which is equipped with a heating system with sufficient capacity to maintain a uniform temperature during periods of severe cold, as sudden fluctuations are very injurious to the plants. Drafts are liable to induce powdery mildew, and the house must be of such construction that strong currents of cold air cannot reach the plants. A large greenhouse containing a great volume of air is usually less subject to sudden fluctuations in temperature and is easier to ventilate without exposing the plants to drafts than small houses.

In the Boston area three-quarter-span houses from 25 to 36 feet wide and 200 to 600 feet long are largely used for the production of cucumbers and other crops. These houses are usually built with the ridge running east and west and with the long side of the roof to the south. Figure 1 shows the exterior of a typical house of this description. The interior arrangement of such a house is shown in figure 2. It will be noted that this house is not fitted with raised benches, but that the crops are produced in ground beds with boards along the walks to keep the soil in place. Many of the houses built according to the arrangement shown in figures 1 and 2 are constructed with wooden posts and wood or cast-iron gutters with pipe purlins and inside pipe posts, while others, mainly of later construc-

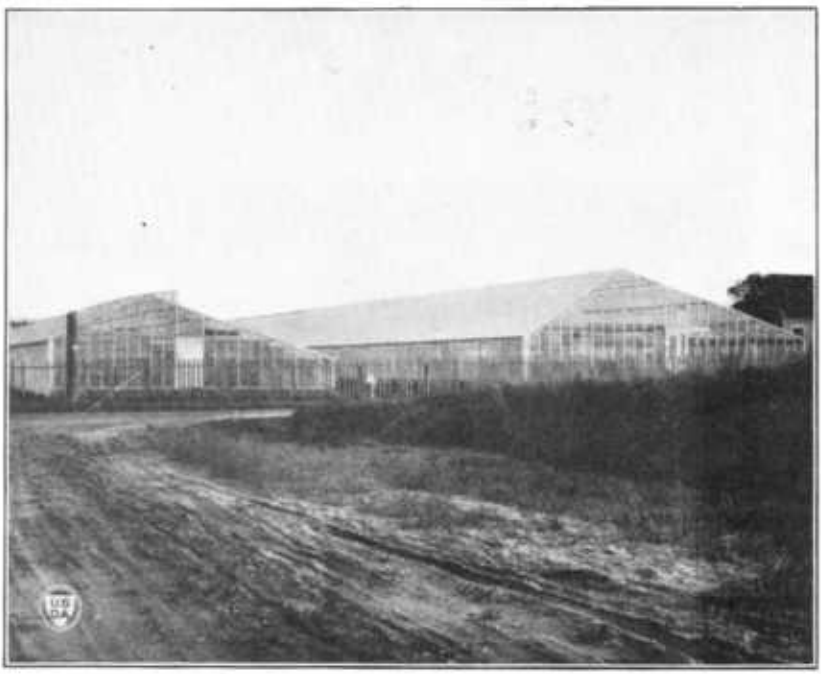

FIGURE 1.—A type of greenhouse extensively used near Boston, Mass., and elsewhere for the production of cucumbers and other forcing crops.

tion, are of the semi-iron type with iron posts having special post-top fittings carrying angle-iron eave plates and with pipe or structural steel purlins, purlin braces, and inside posts.

The ridge-and-furrow type of greenhouse, consisting of a number of equal-sized units built side by side with but two outside walls and with the inside gutters carried on rows of pipe posts, making in effect one large house, is largely employed for the production of cucumbers and other vegetable crops. Figure 3 shows the exterior of such a range of houses. This type of house is used by some of the most successful growers of cucumbers. For the best results it should be built with very high eaves, those with the gutters 8 to 10 feet from the ground being none too high. This plan makes it less difficult to ventilate the house without exposing the crops to drafts from the ventilators.

FIGURE 2.—Interior of a three-quarter-span house in the Boston area. No benches are ordinarily used, and boards or concrete curbs are made to form the sides of the walks and to keep the soil in place.

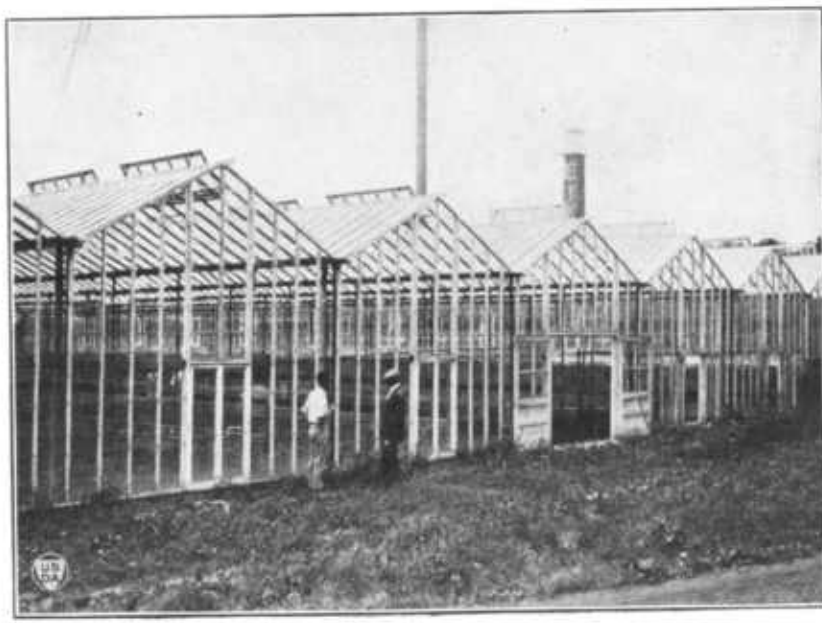

FIGURE 3.—Exterior of a range of ridge-and-furrow houses. The high eaves are a desirable feature. The interior of such a range is shown in figure 8.

Within recent years the large detached house with a steel frame has become very popular for vegetable forcing, and particularly for the forcing of cucumbers. These houses are built as wide as 85 feet and as long as 600 to 800 feet, enclosing an acre or more of ground. These structures contain a large volume of air, and when fitted with proper heating equipment are not subject to sudden fluctuations in temperature. The ridge of such a house is from 20 to 30 feet from the ground, and there is little danger of air currents from the ventilators striking the plants. Figure 4 shows the interior of such a house planted to cucumbers. Very nearly ideal conditions for the production of cucumbers can be obtained in such houses, as they enclose a large space where not only the temperature but other factors governing the growth of the crop are under the control of the operator.

FIGURE 4.—Interior of a large steel-frame house planted to cucumbers.

Cucumbers are successfully produced in many kinds and sizes of forcing structures. The type of house best suited to the needs of the individual grower must be determined by the character of the site, the expenditure which can be made for the structure, and whether the house is to be used mainly for the growing of cucumbers or other crops; but in the light of the experience of successful growers located in many parts of the country the best results can be had through following the suggestions made in the preceding paragraphs.

RELATION OF CUCUMBERS TO OTHER FORCING CROPS

Cucumbers are not a satisfactory greenhouse crop for production during the short days of midwinter, as they demand long daylight hours with plenty of sunshine. They are not very successful as a

fall crop, and many growers produce them during the spring, utilizing their houses during other portions of the year for lettuce and tomatoes. Lettuce is about the only crop forced in a large way that does well in greenhouses in midwinter, and practically all forcing ranges grow it during the winter season. Some growers utilize their houses during the autumn months for the production of tomatoes, follow these with lettuce, and then plant the space to the regular spring crop of cucumbers, thus occupying the ground until midsummer, or until it is necessary to prepare for the autumn crops.

FIGURE 5.—Lettuce planted as an intercrop in a cucumber house. The lettuce is removed before the cucumber plants attain any considerable size.

Other growers plant lettuce early in the autumn and produce two or three crops, then set their houses to cucumbers for the usual spring crop.

COMPANION CROPS

Cucumber plants require a considerable period to come to bearing size, and short-season crops, such as radishes, lettuce, or spinach, are sometimes planted between the rows of cucumbers in order to produce an income from this space during the early stages of the development of the cucumber crop. Cucumbers demand a high temperature, and the conditions are maintained so that this crop will make its best development. While the companion crops do not, as a rule, thrive best when grown between the rows of cucumbers, it is often possible to secure yields which add materially to the income from the houses thus occupied. These secondary crops are harvested before the cucumber plants reach bearing size. Figure 5 shows a house planted to cucumbers with lettuce as a companion crop.

SOILS

Rather light-textured loamy soils are considered best for the production of greenhouse cucumbers, but some of the most successful ranges are located on heavier soils. Soils well supplied with organic matter and with plenty of available plant food are necessary to the production of high-grade cucumbers. As long as these essentials are supplied it does not seem to make much difference as to the exact type of soil upon which the crop is produced, but it should be borne in mind that the lighter soils are easier to work and usually have better natural drainage than the heavier types. Good natural drainage is highly desirable. Careful consideration should be given in locating a new greenhouse enterprise for the production of crops to be grown in the natural soil, as is the practice with most of the vegetable crops. If the original soil is naturally good, its physical character can be greatly modified through heavy applications of manure, lime, and fertilizer and the constant working incident to the production of greenhouse crops.

MANAGEMENT OF THE SOIL

Owing to the high cost of forcing structures and the heavy expenses for fuel and labor to keep the space enclosed in a condition suitable for the crops, it is necessary that the space be fully utilized at all seasons of the year. The greenhouse operator has a more serious problem than that which confronts the outdoor grower, as he must maintain the fertility of the soil and control insects, diseases, and other pests without practicing crop rotation and many other control measures. The nature of these problems has brought about distinct practices for keeping greenhouse soils in a high state of productivity. Glass farming has come to be a highly specialized industry, where the expenses per acre are very high and the returns many times those secured from the most intensive outdoor vegetable growing.

SOIL STERILIZATION

The sterilization of greenhouse soils as an insurance against diseases which may attack the crop is almost universally practiced by vegetable growers in all sections of the country. It is also an effective control for the nematode which causes the root knot of cucumbers, tomatoes, and other crops and is also a distinct aid in controlling insects which pass part of their lives in the soil. Successful vegetable growers sterilize the soil once a year, usually in the middle of the summer, between crops.

Sterilization with live dry steam is looked upon as the most effective method of securing the desired freedom from attack by the various pests. Several methods for sterilizing the soil with steam have been devised, and the one best adapted to the use of the individual grower must be determined by his conditions. One of the oldest methods uses the inverted pan. This apparatus consists of a pan of metal or wood 7 to 10 inches deep, 5 to 7 feet wide, and 10 to 12 feet long. This pan is usually made to correspond to the width of the beds and not too large for the boiler capacity. Figure 6 shows a pan made of sheet metal, this being a desirable type, as it is an easy mat-

ter to force the edges of such a pan into the soil so that the steam will not escape. The steam is admitted through a hose attached to a pipe, as shown in the illustration. The pan is of such dimensions that it just reaches across the 12-foot beds in this range of standard-sized houses. The carriage is so constructed that the pan may be raised clear of the soil and rolled to a new location. The concrete walks are so spaced and arranged that they serve as a track for the carriage carrying the pan. The steam hose is of such a length that several settings can be made without disturbing the connection. Steam is supplied to this 6- by 12-foot pan from a 100-horsepower boiler. It would be impossible to carry any considerable pressure inside the pan, as this would lift it from the ground, allowing the steam to escape. In practice it is usually necessary to place sand

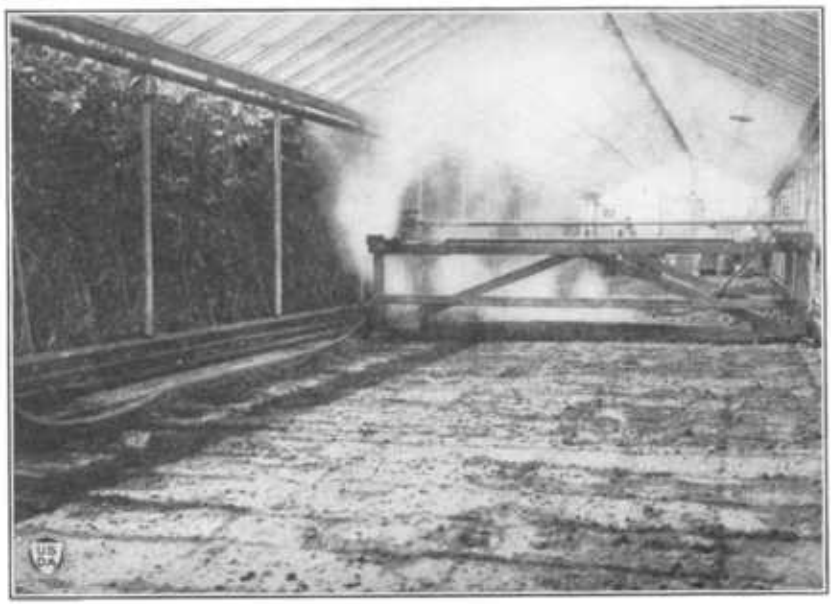

FIGURE 6.—Sterilizing greenhouse soil by the steam-pan method. The pan is moved by elevating it with a special hoisting device and rolling the carriage to a new location. The concrete walks serve as a track for the flanged wheels of the carriage. Steam is admitted through the hose and is supplied by a 100-horsepower boiler.

bags or other weights on the pan to prevent its rising. The penetration of the steam into the soil is influenced by the character of the soil itself. In tests made with the apparatus shown in figure 6 the steam, which was supplied by a 100-horsepower boiler, produced in 30 minutes a temperature of 210° F. at a depth of 12 inches. The soil in this case was a rather heavy loam. While a steam pan may not be equally efficient under all conditions, it would seem that its use makes it possible to secure temperatures which should be an effective control for most of the soil enemies of greenhouse crops. Soil that is either too dry or too wet does not sterilize to the best advantage. For best results it should contain just about the right proportion of moisture to be in good working condition.

Another method widely employed consists in the use of sets of perforated pipes which are buried in the soil about a foot deep, steam

being admitted through a hose connection until the upper 12 or 15 inches of the ground reaches a temperature of 212° F. Pipes 1½ inches in diameter are usually employed in sterilizing. These are attached to 2-inch headers, the pipes being spaced about 1 foot apart and having ⅛-inch holes drilled at intervals of a foot along the bottom. The set of pipes may be as long as desirable, but their number and length are determined by the size and shape of the beds and the available boiler capacity. One concern in northern Ohio uses 2 sets, each made up of ten 1½-inch pipes 85 feet long and spaced 1 foot apart. When both of these are in use at the same time it requires 450 horsepower at the boiler to supply sufficient steam. It is possible for those having small boilers to fit up sterilizing coils of a size suited to their capacity. Figure 7 shows a sterilizer made up of

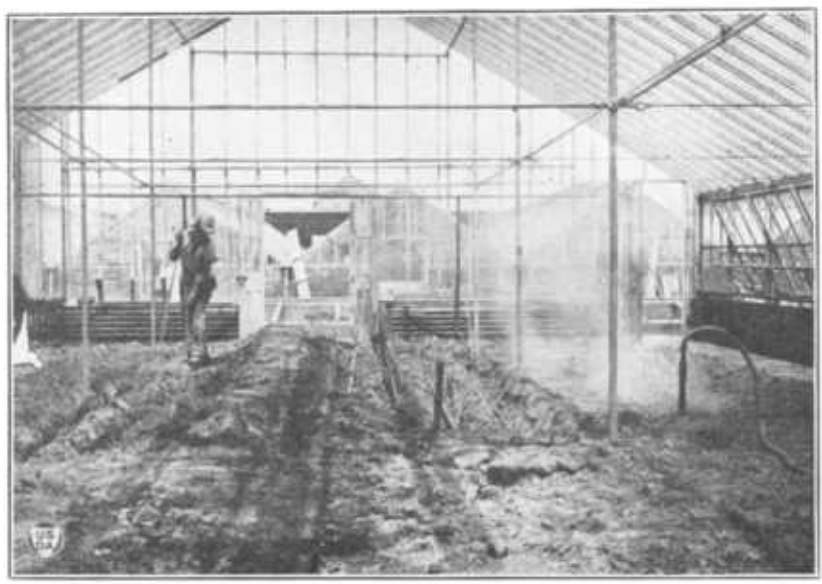

FIGURE 7.—Sterilizing greenhouse soil by the perforated-pipe method. The sterilizer is made up of lines of pipe connected by headers, the size and number of the pipes depending on the size of the beds and the boiler capacity available. The workman is covering one set of pipes while the other is in use.

4 lines of 1¼-inch pipe 20 feet long, spaced 1 foot apart, and fed with steam from a 20-horsepower boiler. A set of these pipes is buried near the right side of the greenhouse shown in the illustration, the steam entering through the hose connection. A workman is covering a second set, so that the connection can be shifted to this and the work carried on continuously. This method is very effective, but it is laborious and costly. Considerable hot, disagreeable work is involved in burying and changing the pipes during midsummer weather, when the sterilization is usually carried on. The quantity of fuel required for sterilizing by the perforated-pipe method is not greatly different from that needed for sterilizing by the pan method, but the labor is greater.

Still another method, known as the steam harrow or rake system, is used to a considerable extent. A framework of pipe of a size

suited to the beds to be treated is fitted with pipe teeth similar to the teeth of a coarse rake. These pipes are of small diameter, usually ½ inch inside diameter and about 6 inches long, with the bottom end closed by being flattened and with ⅛-inch holes drilled through them near the lower end. The teeth are spaced about 6 inches apart in each direction. The apparatus is attached to the steam supply by a hose, and the steam forces its way through the small holes into the soil. In using the sterilizer the teeth are forced into the soil, and the device is covered with a canvas to retain the heat. When the operation is completed in one place the rake is lifted by the workmen and moved forward to the next location. Two or more of these rakes are usually used by the same men, so that the work can go on continuously. This device does very effective work, and the labor involved is not great.

Permanent lines of 4- or 5-inch draintiles are sometimes installed about 1½ feet deep and from 18 inches to 2 feet apart in the greenhouse and live steam turned into these until the soil at the surface reaches a temperature of 212° F. The lines of tile can be used for subirrigation purposes as well as for soil sterilization.

Sterilization is sometimes accomplished by flooding the soil with boiling water or by forcing boiling water into the soil through a pipe fed by a hose connected to the boiler. This method is often practiced in plants where steam is not available, and it gives very good results. One objection to its use is that it leaves the soil in a puddled condition, and considerable time must elapse before it can be prepared for the crops.

A solution of formaldehyde, 1 pound of the commercial solution to 30 gallons of water, used at the rate of a gallon of the solution to each square foot of bed surface, is quite extensively employed for the control of diseases affecting greenhouse crops. The method is expensive and hardly practical for large areas of greenhouse soil, but highly desirable and economical for plant beds, etc. After treatment, the soil should be allowed to lie for several days before seeds or plants are placed in it. Here again, as in steam sterilization, it is important that the moisture content of the soil be normal.

STABLE MANURE

Stable manure is essential to the best results with greenhouse cucumbers. In the past, little difficulty has been experienced in securing ample supplies from the large cities, but this supply has dwindled until it is now impossible to obtain an abundance of good manure at a moderate price. Much of the manure now coming from the large cities is of poor quality. Special precautions should be taken to avoid the use of manure swept from the streets, as this usually contains considerable oil and particles of paving material. Manure from oiled roads also should be avoided, as the oil contained in such material is usually present in sufficient quantity to be distinctly injurious to the plants. It is also advisable to avoid the use of manure mixed with shavings or sawdust, as it is liable to be injurious. Many growers have adopted the expedient of securing their supplies from some nearby dairy or stock farm, often operated as an adjunct to the greenhouse enterprise for the purpose of supplying the manure essential to success with forcing crops.

For growing cucumbers it is desirable that the manure be applied at the rate of 30 to 40 tons to the acre, or about a 2-horse load to every 1,000 or 1,500 square feet of ground. The application of such dressings of manure, made just after the soil is sterilized and before it is plowed, should be looked upon as a necessary practice for maintaining the soil in a high state of productivity. The actual plant-food requirements of the crop should be largely provided for through top-dressings of manure and fertilizers applied from time to time as the plants develop. The application of large quantities of manure involves considerable labor, but this can be reduced by the use of suitable equipment. Large greenhouses should be fitted with doors of such size that the manure can be hauled directly into the house by team. Figure 8 shows the interior of such a house in

FIGURE 8.—Hauling manure into the greenhouse. In this case the manure is spread by hand, but manure spreaders are sometimes employed.

which the manure is being spread preparatory to plowing the ground. In some cases manure spreaders are employed for hauling and spreading the manure in the houses.

PREPARATION OF THE SOIL

In modern vegetable-forcing houses the soil is plowed and prepared largely by a team or by a tractor, but in houses whose construction is such that this is impossible or difficult the work is usually done by hand. Figure 9 shows the plowing in process, a single horse being used in this case, but a moderate-sized tractor capable of turning within a short radius could be employed to good advantage. Most growers believe that the soil should be turned to a depth of at least 10 inches. The method usually employed in incorporating the manure with the soil is to have men place the manure

in the furrow after each round of the plow, thus insuring its being covered thoroughly. Figure 9 shows piles of manure ready to be placed in the furrows as the plowing proceeds.

The preparation of the soil after the plowing is completed is usually accomplished through the use of a disk harrow, a drag, or a similar tool. It is the aim of the best growers to provide a perfectly prepared seed bed 6 or 8 inches deep, and the equipment used to accomplish this result is determined by the nature of each case.

PLANT FOOD FOR THE CROP

A rapid uninterrupted growth is necessary if a satisfactory crop of high-grade cucumbers is to be obtained. This makes it necessary that the soil be well supplied with plant food before the crop

FIGURE 9.—Plowing in the greenhouse with a one-horse plow. The manure is being applied and turned under as the plowing progresses. Sometimes two-horse tools are used, and in other cases small tractors are employed.

is set, so that the young plants will have an immediate supply of all the elements essential to their proper development. In the past many growers have made it a practice to depend almost entirely on manure for the plant food for the crop, but as this does not always supply the quantities of the essential elements needed for heavy yields there is a growing tendency to depend on commercial fertilizers for most of the food supply, with good manure free from shavings, sawdust, or other injurious materials supplying the organic matter and part of the plant food. Applications of 1,000 to 2,000 pounds per acre may be made of a fertilizer containing 4 to 5 percent of nitrogen, about half of which is in the form of nitrate of soda or sulphate of ammonia and half in the form of dried blood or tankage, 7 to 9 percent of superphosphate, and 4 to 5 percent of potash in the form of muriate. Some growers modify this by using

a mixture containing not over 4 percent of potash and apply hardwood ashes containing from 2 to 4 percent of potash at the rate of 1,000 to 1,500 pounds per acre. These materials are usually sown broadcast with a fertilizer distributor or by hand. All these materials are supplied during the final stages of the preparation of the soil and are supplemented by special applications while the crop is growing.

LIME

Owing to the intensive cropping systems followed in the greenhouse, the soil is liable to become acid, and lime must be used to correct this acidity. The need for lime may be determined by testing with litmus paper or by a lime determination in a laboratory, or, what is usually the best practice, the greenhouse man may make experimental applications from time to time, using the information thus secured as a basis for the treatment of the remainder of the range. The cost of lime is low, and the grower should not take the chance of poor crops because of lack of lime in his soil. The form in which the lime should be applied must be determined by conditions. If quick results are desired the use of ground stone lime or hydrated lime may be advisable, but where a slower acting form is desirable ground limestone is satisfactory. Applications of from 1,000 to 2,000 pounds per acre will usually be found sufficient. It is better practice to make rather frequent, small applications than to give heavy treatments at infrequent intervals. The use of lime more than once each year is seldom necessary.

VARIETIES AND SEED

Two distinct classes of cucumbers are used for forcing in the United States. The English forcing type is represented by such varieties as the Telegraph and the Duke of Edinburgh. Cucumbers of this class are extensively grown in forcing houses in the eastern portion of the country and to a slight extent in the Middle West and the West. The major portion of the cucumber crop produced in this country is of the American field type, of which special forcing strains have been developed. In some cases crosses have been made between the English forcing varieties and the American sorts. The Abundance and Davis Perfect are two of the best-known crosses, and these are extensively grown. A sort known to growers as the Long Green is probably a selection of the Telegraph and is quite largely grown by vegetable-forcing interests in Ohio and Michigan. Most of the American forcing strains belong to the White Spine group. Some of the best-known varieties of this group are the Improved Arlington White Spine, the Extra Long White Spine, and the Evergreen White Spine. Many growers have developed strains of their own and save their own seed from year to year, and some of these have been named as varieties. Such a selection, known as the Irondequoit, is grown in the Rochester, N. Y., area.

Sometimes the seed crop is grown out of doors during the summer months, and in other cases it is saved from the greenhouse crop. In either case selected plants are set aside for seed purposes and the entire supply is secured from those plants having the desired characteristics. The general character of the plant, including its vigor, pro-

ductiveness, resistance to disease, and longevity, is taken into account in making the selection. The success of the greenhouse crop depends to a large degree on the seed; hence, extreme care should be exercised to secure a satisfactory supply.

MANAGEMENT OF THE CROP

STARTING THE PLANTS

Strong healthy plants are essential to a satisfactory crop of greenhouse cucumbers. It is desirable that the crop occupy space in the houses for as short a time as possible, so as to make room for the greatest number of crops during the year. For this and other reasons the plants are usually started in a separate house where they can

FIGURE 10.—Cucumber plants in 4-inch pots. The seed for these plants was sown in a bed and the plants transferred when about 2 weeks old. Often the seed is placed directly in the pots or other containers used.

be given special care, and when several weeks old they are placed in the house where the crop is to be produced. Figure 10 shows the interior of a house used for the production of plants for a large range. Part of this house is fitted with benches to facilitate the handling of the plants. The benches, flats, tools, and all the equipment used in the production of the plants should be thoroughly disinfected each time a crop is produced. This may be accomplished by spraying or washing the equipment with a solution made by adding 1 pound of formaldehyde to 30 gallons of water or by dissolving 6 ounces of corrosive sublimate in 50 gallons of water. It is an excellent plan to keep in one of the plant houses all the tools needed for the production of the plants and to allow no transfer of such equipment without sterilization from other parts of the range to the plant houses, as such a practice might introduce diseases from

the other houses to the section where the plants are being grown. It is also unwise for the workmen handling the crop in other sections of the range to have access to the plant house, as diseases may be carried on their hands and clothing to the young plants. When the same person is required to look after the work in various portions of the range, it is well for him to sterilize his hands in a solution of mercuric chloride of the same strength used for the benches and tools; also to change his outer clothing before entering and handling the young plants. Special precautions are necessary, as usually some disease is present in the bearing crop, and if the young plants become infected their chances for developing into strong high-producing plants are materially lessened.

Soil used for the production of cucumber plants must be of good physical character and well supplied with available plant food. A soil prepared by composting 2 parts of old bluegrass, redtop, or other suitable sod and 1 part of cow manure is usually satisfactory, although many growers make a practice of adding 2 or 3 pounds of bone meal or a high-grade fertilizer to each ton of the soil. A mixture containing 4 to 5 percent of nitrogen in the form of dried blood and nitrate of soda or sulphate of ammonia in equal proportions, 7 to 8 percent of phosphoric acid, and 3 to 4 percent of potash is suitable for this use. Soil needed for the production of cucumber plants for a spring crop should be composted during the previous autumn, turned once or twice during the late fall before severe freezing weather occurs, and brought into the plant house during the early winter, so that it will be available when needed for starting the plants. The soil should not be allowed to dry out while being prepared for the production of the plants, and the aim should be to keep it in a satisfactory condition for plant growth. When fertilizer is used it is as a rule mixed with the soil at the last turning before the crop is to be started. In the final working of the soil it is a good practice to use a screen of about ½-inch mesh, similar to a coarse sand screen, so that all lumps and foreign material can be broken up or removed. The screen illustrated in figure 11 is well adapted to the work. Time and care devoted to the preparation of the soil for the production of cucumber plants will pay good returns.

Sterilization of the soil used for the production of cucumber plants is extremely desirable, and the process should be carried on at least 2 weeks before the seed is to be sown. Sterilizing may be accomplished by spreading the soil on the floor of the greenhouse or on one of the benches and using the steam pan already described and illustrated in figure 6, or the soil may be placed in flats which are stacked on a truck and run into a cabinet, as shown in figure 12. This cabinet is of concrete with a wooden door. One can be constructed of lumber or of metal and need not be expensive. Steam is admitted through the top by means of a pipe leading to the boiler and is distributed by a perforated pipe running the length of the cabinet. In practice the steam is admitted until the soil reaches a temperature of about 212° F., this usually requiring about half an hour. In some cases the soil is sterilized in bulk in a cabinet, but this means additional handling. Sterilization in an oven or by fire is not usually advisable, as it injures the productive qualities of the soil.

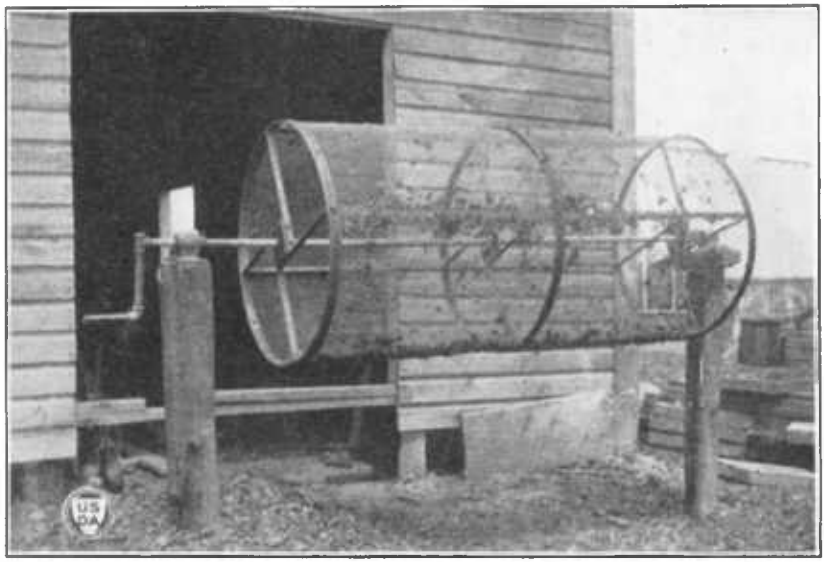

FIGURE 11.—A type of screen well adapted to the preparation of the well-fined potting soil needed for the production of cucumber plants. Such a screen can be operated by power if desired.

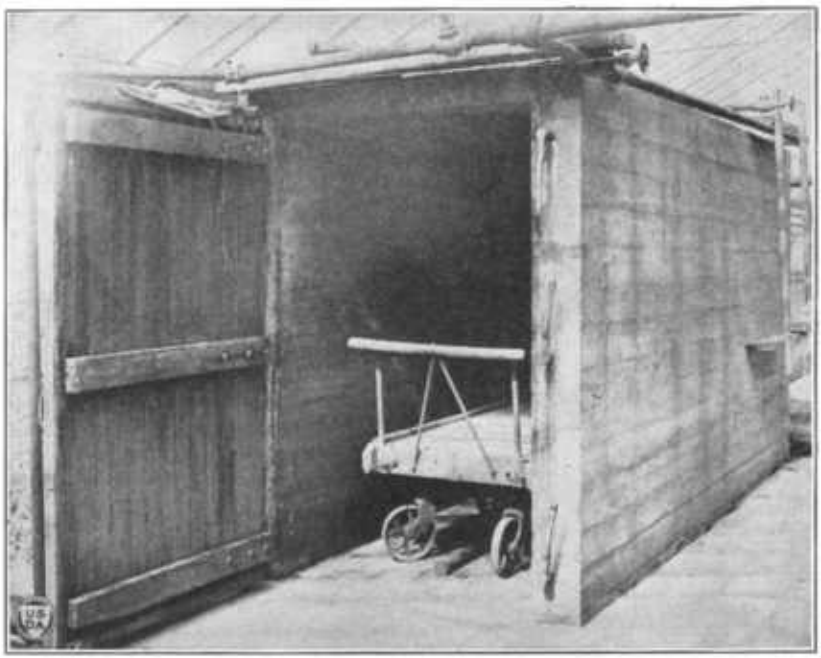

FIGURE 12.—A concrete cabinet for the sterilization of soil for the production of cucumber plants. The soil is placed in the containers in which the plants are to be grown and these put in the cabinet, the door closed, and the steam admitted through the pipe in the top of the cabinet until the soil is heated to 212° F. From a half hour to an hour is usually required.

Several methods are employed for the production of greenhouse cucumber plants. (1) The seed is sown in beds and covered with one-half inch of sandy loam, leaf mold, or finely divided peat. As soon as the seedlings are up, which will be in about a week, they are transplanted to 3- or 4-inch pots or to veneer plant bands which are set in flats or directly on the benches of the plant house, as shown in figure 10. Some growers transplant the seedlings to 2-inch pots and make a second transplanting to larger pots, but as this entails considerable extra work and the results do not seem to be markedly superior to those secured with one transplanting, the practice of making two transplantings is not generally followed. (2) The seed is placed in the pots or the plant bands employed and covered with one-half inch of leaf mold, peat, or some similar material which will not pack. Several seeds are usually placed in each container and the resulting plants, thinned to two and finally to one, are grown on the benches in the plant house. This method may be modified by using a piece of inverted sod, a paper band, or some other device for supplying the plant with a mass of soil in which its roots can develop and which can be transferred to the location where the plant is to grow without disturbing this root system.

Extreme care must be taken in handling the plants, as stunted and diseased seedlings will not give a satisfactory crop. It is a far better practice to grow the plants under the most favorable conditions in the shortest practicable number of days consistent with sturdiness and vigor than it is to sow the seed too early in the season and depend on bringing the plants to the correct size by planting time. With the proper conditions, it is possible to secure strong, healthy plants having several leaves and beginning to vine in from 5 to 6 weeks from the seed.

The temperature and general management of the cucumber house are very important factors in the production of good plants. The young plants are particularly sensitive to low temperature. Night temperatures of 65° to 70° F. and day temperatures of 75° to 85° will usually give good results. The house must be properly ventilated, but this should be accomplished without sudden changes in temperature, and it is especially necessary that drafts be avoided. While the plants need considerable water, it is an easy matter to use too much, with resultant trouble from "damping-off." Insects should be controlled by the same measures used for the main crop, as explained elsewhere in this bulletin.

SETTING THE PLANTS

The most satisfactory planting distance will depend on the training system adopted. Three main systems of training cucumbers are in use, but several modifications of these are described in this bulletin. The planting distance must be made to accord with the system followed. When the A-trellis system is to be used, the plants are set in rows from 7 to 9 feet apart with the plants from 10 to 18 inches apart in the row. The distance between the rows is usually proportioned to the width of the houses. With the "arbor" system the plants are set in rows 6 to 7 feet apart, with the plants from 2½ to 3 feet apart in the rows. The width of the rows may be varied in this case also to suit the dimensions of the house. When using

the other important system the plants are trained to stakes or strings attached to wires stretched across the house, and each plant is kept free and distinct from its neighbors. The distance between the rows ranges from 3 to 4½ feet, with the plants from 1 to 2 feet apart in the rows. The closer the rows are, the farther apart are the plants in the rows.

Cucumber plants should not be placed in the houses until the ground has been thoroughly prepared. It is very important to have the soil in a satisfactory condition to promote growth as far as moisture and temperature are concerned. The rows must be straight, and this is usually accomplished with the aid of garden lines, or the ground may be marked out with a horse-drawn tool. If the plants

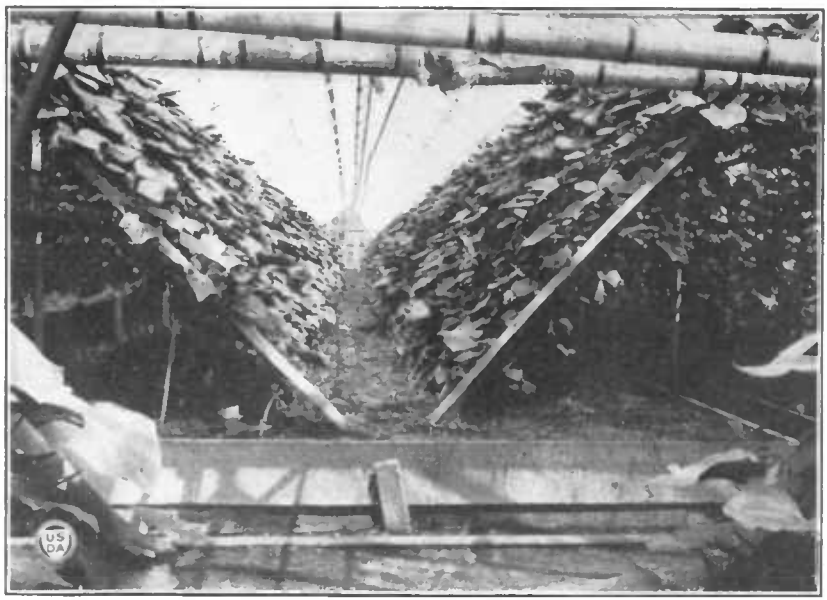

FIGURE 13.—Form of trellis largely employed for training cucumbers. The framework is of 2- by 4-inch or 3- by 4-inch scantling, and wires are stretched horizontally every few inches. The cucumber plants are trimmed to a single stem, trained, and tied to these wires.

have been grown in pots, each may be removed with the ball of soil intact by turning the pot upside down and tapping the edge of it on some projection, such as the handle of a wheelbarrow, catching the plant in the other hand as it loosens from the pot. If the plants are well watered before planting is begun, it will be a distinct help in keeping the soil surrounding the roots from crumbling. If wooden or paper bands are employed for growing the plants, these may be slit down the side or one corner and removed before setting the plants in the hole previously prepared. The soil should be well firmed around the plant after it is placed in the hole, and it is advisable to follow the planting very closely with a moderate application of water around the roots of the plants. A little manure used as a mulch about the freshly set plants is a decided advantage.

TRAINING

Figure 13 illustrates the A-trellis method of training the plants. The trellis is usually constructed of 2- by 4-inch scantlings mitered together at the top and set in the ground at the bottom, usually with the apex of the trellis over a path. These timbers are from 7 to 10 feet long, depending on the width of the house and the distance between the rows, and are placed sufficiently close to prevent the sagging of the wires. Horizontal wires are stretched every few inches and fastened to the scantlings by staples. As the vines grow they are trimmed to a single stem and tied to the wires, one after another, as the growth of the vine progresses. The lateral shoots are nipped off just beyond the first female flower, and when the vine reaches the top of the trellis the terminal bud is nipped off. It is seldom practicable to keep the vines perfectly pruned, but unless the work is looked after with extreme care an excessive vine growth will soon result.

When trained and pruned according to the "arbor" system every plant is trimmed to a single stem and trained to a string or wire attached to an anchor or stake set beside each. These supports are attached to a horizontal trellis 6 or 7 feet from the soil and fastened to the frame of the greenhouse. This trellis is usually made of wires placed at sufficiently close intervals to form enough support to sustain the plants as they spread over its surface. Each plant is allowed to set several cucumbers while it is reaching the trellis, but after the vines begin to spread over it they shade the underneath portion so much that further development of fruit or foliage is not possible. As soon as the plants reach the trellis the terminals are nipped off, with the result that several lateral branches arise near the place where the terminal was cut. These spread over the supports, and the cucumbers are borne hanging through the trellis. Some pruning is necessary from time to time to prevent too rank a growth of foliage. Figure 14 shows the interior of a house where this system of training is in use.

A house where the upright system of training is employed is shown in figure 4. Each plant is trimmed to a single stem and either tied to a slender lath attached to overhead wires carried by the frame of the house or to a heavy string attached to a similar support. Many growers prefer the string supports, as the vines can be twined around the strings as the growth progresses, thus avoiding a great deal of the tying necessary when lath supports are employed. The lateral shoots are cut off just beyond the first female flower, and the plants are often carried to a height of 8 feet from the ground before the terminal shoot is nipped. Considerable training is necessary to keep the plants within bounds. This system allows the sun to have free access to the plants, and under such conditions there is less liability of diseases developing. Modifications of these systems can readily be made to suit the conditions of each grower.

TEMPERATURE AND VENTILATION

Most growers believe that cucumbers do best with a night temperature of from 65° to 70° F. and a day temperature of 75° to 85°. While there is a difference of opinion as to the exact temperature needed by the crop, there is none as to the necessity for a uniform

temperature. Marked fluctuations in temperature are injurious to the crop, and sudden changes are distinctly harmful. The houses must be equipped with heating apparatus that will maintain a steady, uniform temperature; moreover, the desired temperature must be maintained while suitable ventilation is given. A large part of the material used by the plant in its growth comes from the air in the form of carbon dioxide. The atmosphere normally contains but a small percentage of this constituent, and it is necessary that the plants have fresh air in order to thrive. Ventilation must be given without subjecting the plants to drafts, as they will induce powdery mildew and other troubles. By opening the ventilators on the side of the house away from the direction of the wind it is usually possible

FIGURE 14.—The "arbor" system of training cucumber plants, in which the vines are allowed to spread over a trellis some 7 feet above the ground. Strings tied to anchors in the soil and to the overhead trellis support the vines until they reach the trellis.

to secure sufficient ventilation without a draft. Some air enters through doors, crevices, etc., and a large portion of the necessary fresh air may reach the plants in this manner. Successful cucumber growers pay close attention to the ventilation of the houses, opening and closing the ventilators as often as necessity arises. A sudden overcasting of the sky or a thunderstorm may necessitate closing the ventilators quickly, and the clearing away of the clouds may require the opening of them just as quickly. Cucumber houses must have constant attention.

CULTIVATING AND FEEDING THE CROP

When the soil has been given the proper preparation before the plants are set in the houses, cultivation becomes a simple matter and

is limited to the maintenance of a soil mulch and the control of weeds. While it is necessary to cultivate the crop during its early stages, many growers believe that there should be little stirring of the soil after picking begins. The cucumber is a very shallow rooted plant, and it is an easy matter to injure it through deep cultivation. Many growers make a practice of applying a mulch of fine strawy horse manure to keep the soil from packing and to control weeds, thus avoiding the necessity of stirring it. This mulch as a rule is not applied until after the plants begin bearing. Such a covering adds considerable plant food to the soil and is a distinct help in controlling moisture and in securing good yields.

Applications of stable manure and fertilizers, as discussed in considering the preparation of the soil, will usually be sufficient to provide for the needs of the crop during the early stages of its yielding period. The plants are exceedingly heavy feeders, and if profitable yields of cucumbers are to be expected the grower must fertilize them liberally. While good manure mulch applied about the time the plants come into bearing is a distinct help, this needs to be supplemented by the addition of such organic fertilizers as dried blood, pulverized sheep or cattle manure, or tankage. Chemical fertilizers, such as nitrate of soda, sulphate of ammonia, superphosphate, or muriate of potash, may be employed, but these can be used in limited quantities only. Applications of 5 to 10 pounds of dried blood or tankage may be made to each 1,000 square feet of ground surface. Nitrate of soda or sulphate of ammonia should not, as a rule, be used at a rate greater than 200 pounds per acre at a single application. The potash salts may be used at a somewhat heavier rate, while superphosphate can be safely employed at a rate as high as 600 to 800 pounds per acre. The individual grower must study his conditions and learn the best fertilizer practice for him to follow. Where it is possible to secure plenty of manure, it is unnecessary to use large quantities of commercial fertilizers. If it is possible to secure such fertilizing materials as wood ashes, they may supply the cheapest form of potash. Irrespective of its source, plant food must be supplied in sufficient quantities to keep the plants in a vigorously growing condition.

POLLINATION

Both male and female flowers are borne on the same cucumber plant. The female flowers may be readily distinguished from the male by the presence of the small cucumber between the flower and the stem. Figure 15 shows both male and female flowers on the same plant. The male flowers usually appear first, and this sometimes creates the impression that cucumbers will not be formed. This habit of the plant seems to be a provision of nature to insure a supply of pollen when the female flowers are ready. Pollination must be performed by some outside agency, and in greenhouse practice bees are usually employed for the purpose. The hives are kept either on the outside of the houses, usually with a pane or two of glass removed, and the hive so placed that the bees enter the house through these openings, or the hives may be inside the houses. The number of swarms required to properly pollinate the cucumbers depends on the strength of the swarms and the size of the house. One strong swarm is usually sufficient for a medium-sized house, while

the very large houses now extensively employed for the forcing of cucumbers may require 6 to 8 swarms. The bees used for this work must be carefully looked after, and most operators make a practice of feeding them regularly, as they do not seem to be able to secure sufficient food from the cucumbers. The hives, as a rule, are used

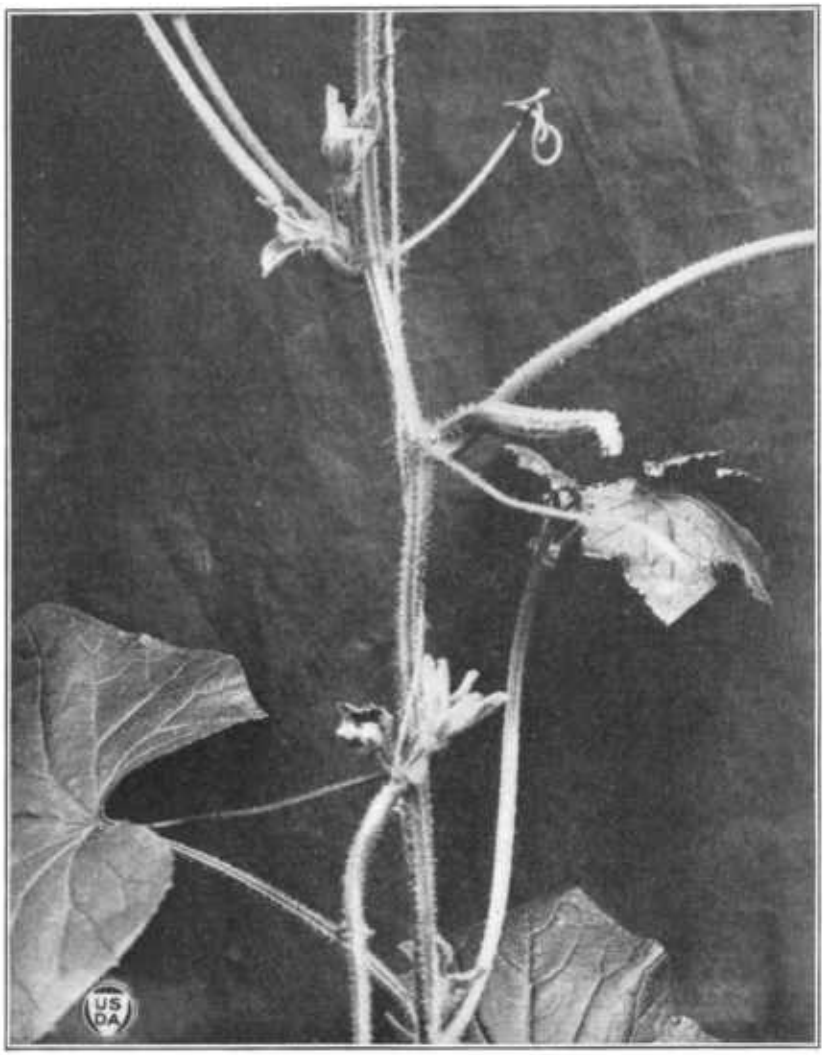

FIGURE 15.—The male and female flowers of the cucumber. The flower of the female blossom is withering, and the small cucumber is seen.

for only a few weeks at a time and then returned to the apiary for a rest. Some of the larger greenhouse concerns maintain apiaries to supply them with bees for pollinating the cucumber blossoms. The work is sometimes done by hand, a camel's-hair brush being used in transferring the pollen, but this method is laborious and is not to be recommended except for very small houses.

WATERING

Cucumbers thrive best when liberally supplied with moisture, but the application of water may very easily be carried to the point where it becomes injurious. Many growers believe that it is better to give the soil rather heavy and less frequent applications. Many cucumber houses, especially those built during recent years, are equipped with overhead irrigation systems. Some growers believe that these systems interfere with the work of the bees, but if the watering is done while the bees are not at work, this objection does not apply. The use of such a system saves a great deal of hand work, distributes the water evenly, and the spray is a help in controlling the red spider. Should anthracnose, downy mildew, or angular leaf-spot appear, overhead irrigation should be discontinued or used very sparingly.

ENEMIES[1]

Sanitation is the most effective method of controlling greenhouse pests. Soil sterilization and the destruction of old plants by fire are also effective as control measures. The burning of sulphur or the vaporization of naphthalene just before the old crop is removed is effective in preventing reinfestation of the next crop with red spider, thrips, and other pests. Control methods for each particular pest are discussed in detail in the following paragraphs.

Growers having difficulty with insect pests should write to their State entomologist, or to the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture at Washington, D. C.

RED SPIDER

One of the serious pests affecting greenhouse cucumbers is the red spider (*Tetranychus telarius* L.), which works on the foliage and, unless controlled, is almost sure to ruin the crop. Numerous control measures are used. Probably the most satisfactory method is to sterilize the soil with steam, as previously described, the sterilization being carried on during the summer months while the houses are unoccupied by crops. The absolute control of weeds, both in and around the greenhouse in summer, is a distinct help in controlling the red spider. Fumigation with either hydrocyanic-acid gas or tobacco is ineffective, but during the past few years naphthalene has come into considerable use as a specific fumigant for red spiders and thrips. For information concerning its use growers should write directly to the Boyce-Thompson Institute, Yonkers, N. Y., or to the Massachusetts Agricultural Experiment Station, at Amherst, Mass.

Syringing with water (provided weather conditions permit) is useful in checking the rapid increase of red spiders, and the widespread adoption of the overhead sprinkler system for applying water to greenhouse crops has made it possible to hold down the ravages of this pest on cucumbers.

In recent tests a derris extract (diluted 1 part in 2,500 parts of water to give a rotenone content of 1 to 60,000 with total derris

[1] Prepared by W. H. White, principal entomologist, in charge, Division of Truck Crop and Garden Insects, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

extractives of about 1 to 15,000) and sulphonated castor oil added as a wetting agent at the rate of 1 part in 400 parts of the prepared spray gave considerable promise in the control of this pest on cucumber, and its use is recommended. Proprietary derris sprays should be diluted and used as directed on the label of the container in which they are sold.

Pyrethrum used either as a spray or dust has thus far proved ineffective in the control of red spiders.

The so-called "white oil emulsions" are also effective in controlling the red spider on cucumbers. In using these the directions given on the label of the container should be carefully observed; otherwise injury is likely to be experienced.

GREENHOUSE WHITE FLY

Few insects are more widely found in greenhouses than this white fly (*Trialeurodes vaporariorum* W.). It is particularly destructive to the greenhouse cucumber; unless vigorously combated, it will soon ruin the crop. The mature insect may be recognized by its characteristic white color and its habit of flying when plants on which it is working are disturbed. The immature forms may be found on the under side of the leaves as translucent whitish bodies.

The standard remedy is fumigation with hydrocyanic-acid gas, which is produced either by the sodium cyanide "pot method" or by the use of calcium cyanide. In the pot method the gas is generated by adding sodium cyanide to sulphuric acid and water. Sodium-cyanide fumigation has in recent years been virtually supplanted by the use of calcium cyanide, as this chemical in the form of fine granules, prepared especially for greenhouse use, can be merely scattered on the ground in the walks between the beds or benches.

For cucumbers, use from one-eighth to three-sixteenths of an ounce for each 1,000 cubic feet of air space and expose overnight. It is safer to begin with the ⅛-ounce dosage, especially in very tight houses; if this strength fails to kill all of the adults, the amount may be gradually increased until a killing dosage is reached. Cucumber foliage is very susceptible to the action of the gas, and serious injury to the plants may result if the above-mentioned amount of calcium cyanide is exceeded, except in case of older or leaky houses. The houses should be thoroughly aired before the sun hits them the following morning in order to avoid unnecessary burning from its rays. For the best results, the crop should be on the "dry side" during the fumigation. If the plants and soil are too moist, burning will sometimes follow. It is necessary to repeat the fumigation 2 or 3 times at intervals of 8 to 10 days before complete control is obtained.

The cyanide and the resulting gas are deadly poisons and must be employed with the greatest caution.

More complete information on the proper method of fumigating with this material is contained in United States Department of Agriculture Department Circular 380, Calcium Cyanide as a Fumigant for Ornamental Greenhouse Plants.

APHIDS OR PLANT LICE

Several species of aphids or plant lice attack greenhouse cucumbers. These insects sap the vitality of the plants by sucking the

juices from the foliage and stems. In case of an incipient or localized infestation, spray with a nicotine or other contact insecticide such as pyrethrum or derris.

A spray solution of nicotine sulphate (containing 40 percent of nicotine) and soap gives satisfactory control. The soap acts as a spreader, producing an even distribution of the spray over the leaf surface. Ordinary laundry soap will answer the purpose. In small quantities the spray is made up as follows:

Nicotine sulphate solution (40 percent nicotine)	1 teaspoonful
Soap	1-inch cube
Water	1 gallon

The soap is first dissolved in a small quantity of hot water and then diluted before the nicotine sulphate is added.

It is essential that the application be thorough so that the insecticide will come in direct contact with the body of the insect. For more detailed information on the use of sprays and dusts for controlling these aphids consult United States Department of Agriculture Farmers' Bulletin 1499, The Melon Aphid and Its Control.

If an infestation is general throughout the house, fumigation with the calcium cyanide, as recommended for the white fly, is a more effective and practical way to control this pest. Another method is to fumigate with smoke from burning tobacco stems or from some of the special nicotine-saturated papers or powders on the market.

THRIPS

In the spring and early summer, thrips often cause serious injury to cucumbers grown under glass. The onion thrips (*Thrips tabaci* Lind.) which is the species most often involved, is extremely small; it is pale lemon in color, but with a blackish tinge. Like white flies and aphids, they extract the vital juices of the plant at the point of attack. They are most frequently found on the foliage and cause it to turn brown and die.

In recent tests a spray consisting of derris with sulphonated castor oil (turkey-red oil) added as a wetting agent (as discussed in the section on the red spider) produced a very high kill of the larvae and adults, and its use is recommended. Commercial preparations of derris with or without pyrethrum used as directed are also effective.

STRIPED CUCUMBER BEETLE

The striped cucumber beetle attacks greenhouse cucumbers, but such infestations are usually the result of growing near the greenhouse out-of-door cucumbers or cucurbits which act as sources of infestation for the indoor plants. Obviously, there is more danger of infestation with the fall crop, as the insects may come from out-of-door cucurbits nearby. The most effective control measures are to avoid growing out-of-door cucurbits near the greenhouse and to destroy old plants which may serve as harboring places for the insects.

Spraying with pyrethrum is effective in controlling this pest. Such sprays should be used as directed on the labels of the containers. Another method consists of dusting with a mixture of 1 part of calcium arsenate and 15 parts of gypsum or land plaster. This material, besides being a stomach poison, also acts as a repellant. The plants

should be kept well covered with the mixture until the infestation has been brought under control.

DISEASES

Practically all the diseases that attack cucumbers in the open may affect the crop when grown in the greenhouse. Sanitation, or keeping the house clean, and the prompt destruction by fire of diseased and dead plants, coupled with steam sterilization of the soil at least once each season, will do much toward controlling the various diseases affecting greenhouse cucumbers. Should anthracnose, downy mildew, or angular leaf spot appear, overhead irrigation should be discontinued or used very sparingly.

ANTHRACNOSE

Anthracnose, a fungus disease, caused by *Colletotrichum lagenarium* (Pass.) Ell. and Hals., attacks the leaves, stems, and cucumbers and is characterized by dead brownish spots, one-fourth to one-half inch or more in diameter, on the leaves, and by discolored and shrunken areas on the stems. Thorough spraying with bordeaux mixture made according to the 2–4–50 formula will check the disease and prolong the life of the plants. Spraying should be begun when the first signs of disease are seen and repeated at weekly intervals. More important, however, is the use of new or steam-sterilized soil for the crop and treating the seed for 5 minutes before planting in a 1–1,000 mercuric-chloride solution, followed by thorough washing in water.

POWDERY MILDEW

Powdery mildew, caused by *Erysiphe cichoracearum* DC., is common on greenhouse cucumbers and causes a whitish, powder-like growth on the foliage. Eventually these spots turn brown and dry, and in severe attacks the affected foliage may be killed. The disease can be controlled to a large extent by taking care to provide even temperatures and proper ventilation, as described on page 19. Spraying with bordeaux mixture or dusting with sulphur at 10-day intervals is recommended for the control of the disease.

DOWNY MILDEW

Downy mildew, caused by *Pseudoperonospora cubensis* (Berk. and Curt.) Rostew., is characterized by numerous small, angular, yellowish spots on the leaves, which eventually cause the yellowing, curling, and death of the foliage. It is one of the most serious diseases of greenhouse cucumbers. Fluctuating temperature, improper ventilation, and excessive moisture all tend to aggravate the trouble. Thorough and timely spraying with 2–4–50 bordeaux mixture helps to control mildew, but the application of preventive measures in careful management of the houses and the crop is to be recommended. The mildew is usually introduced into the houses from nearby greenhouses or fields where a diseased vine crop has been grown. Hence, the disease may be prevented from getting into the houses by keeping vine crops as far as possible from them.

BACTERIAL WILT

Bacterial wilt, caused by *Baccillus tracheiphilus* Erw. Smith, often affects greenhouse cucumbers. It is characterized by a wilting of the plants, due to the growth of bacteria in the water vessels causing toxins, and is similar in appearance to the wilting caused by lack of water. Death soon results, and the disease often causes serious losses. Bacterial wilt is transmitted from plant to plant, as well as carried over winter, by the striped cucumber beetle, and possibly by other insects, and rigid control of these will materially aid in controlling the disease. Wilted plants should be promptly pulled and burned or buried.

MOSAIC

Cucumber mosaic is characterized by mottling and curling of the leaves, by warted, mottled, or irregular fruits, and by a dwarfed growth of the plant. Like many other mosaic diseases, it is caused by a virus which is transmissible in the juice of diseased plants carried by insects, chiefly striped beetles and aphids, and by pickers. It is carried over winter in the seed of the wild cucumber, in the perennial rootstocks of the common milkweed and pokeberry, and in other host plants, but not to any important extent in the seed of the cultivated cucumber. The best control measures for mosaic in the greenhouse include regular fumigation to control insects which spread the disease and the prompt removal of mosaic plants to avoid its further spread during pruning and picking operations. All wild cucumber, milkweed, pokeweed, and other overwintering hosts in the vicinity of the houses should be dug up and burned. For more detailed information on the control of mosaic, see United States Department of Agriculture Department Circular 321, Control of Cucumber Mosaic in the Greenhouse.

ROOT KNOT

Greenhouse cucumbers are subject to serious injury by nematodes (*Heterodera marioni* (Cornu) Goodey), or small eelworms, which infest the roots of this and many other plants, causing characteristic knots or swellings. These interfere with the normal activities of the plant, and unless protective measures are taken the pest will overrun the whole range of greenhouses, making it impossible to produce good crops. Steam sterilization of the soil is an effective control measure, and practically all growers of cucumbers in greenhouses look upon sterilization as a necessary measure. Owing to the habit of the pest of penetrating deeply into the soil, and even under the walks, it is necessary that the sterilization be very thorough.

Certain other less serious diseases may attack the cucumber in the greenhouse, but these may ordinarily be controlled by seed treatment and proper greenhouse management, including soil sterilization, ventilation, and sanitation.

HARVESTING, GRADING, AND PACKING

Under ordinary conditions, about 90 days elapse from the time the seed is sown until the harvesting of the crop begins. The cucumbers must be gathered at frequent intervals, as their market quality

is injured if they are left on the vines too long, and the vines themselves are hurt if the cucumbers remain until the seeds begin to harden. It is usually sufficient to go over the vines every other day. The cucumbers are removed by severing the stems with a knife. It is not advisable to break off the cucumbers, as this may injure both the vines and the cucumbers. In small houses it is a simple matter to carry the crop to the packing house, but in large houses some form of conveyance, such as a truck running on the concrete walks of the house, must be employed. A hand truck suitable for the transportation of the cucumbers to the packing house is shown in figure 16, which also illustrates the methods followed in grading and packing the product. As a rule, 3 or 4 grades are established, according to quality. The no. 1 grade consists of those cucumbers that are straight, uniformly cylindrical, and of uniform color. The no. 2

FIGURE 16.—The packing house of a large greenhouse range producing great quantities of cucumbers. The truck is used to transport the cucumbers from the greenhouse to the packing house. Only the best grades are packed in the boxes, the poorer grades being packed in hampers and barrels.

grade consists of those varying slightly in shape and color from the best grade, while the no. 3 grade contains those enlarged at the ends or enlarged or constricted in the middle and not of uniform color, while the other grade includes the nubbins, used mainly for salads, where the shape does not make much difference. Figure 17 shows the four grades into which the product of a large Middle West greenhouse range is divided. The variety in this case is the Telegraph. The kind of packages used depends upon local customs and upon the demands of the markets to be supplied. In some cases splint baskets holding from 2 to 3 dozen cucumbers are employed. In other cases crates holding from 5 to 6 dozen are used. Figure 18 shows the containers used by the concern whose packing room is shown in figure 16. The boxes are used for the best of the crop and

hold from 1 to 2 dozen cucumbers. The hampers and barrels are employed for the other grades. A large producer in northern Ohio packs his entire product in barrels, but it is carefully graded and only one grade placed in a container. In the Boston district, greenhouse cucumbers are packed in standard bushel lug boxes. The use of attractive containers, such as the boxes shown in figure 18, is a material aid in disposing of the crop.

Ready access to markets which will easily consume the product of the range is desirable. These markets may be within trucking dis-

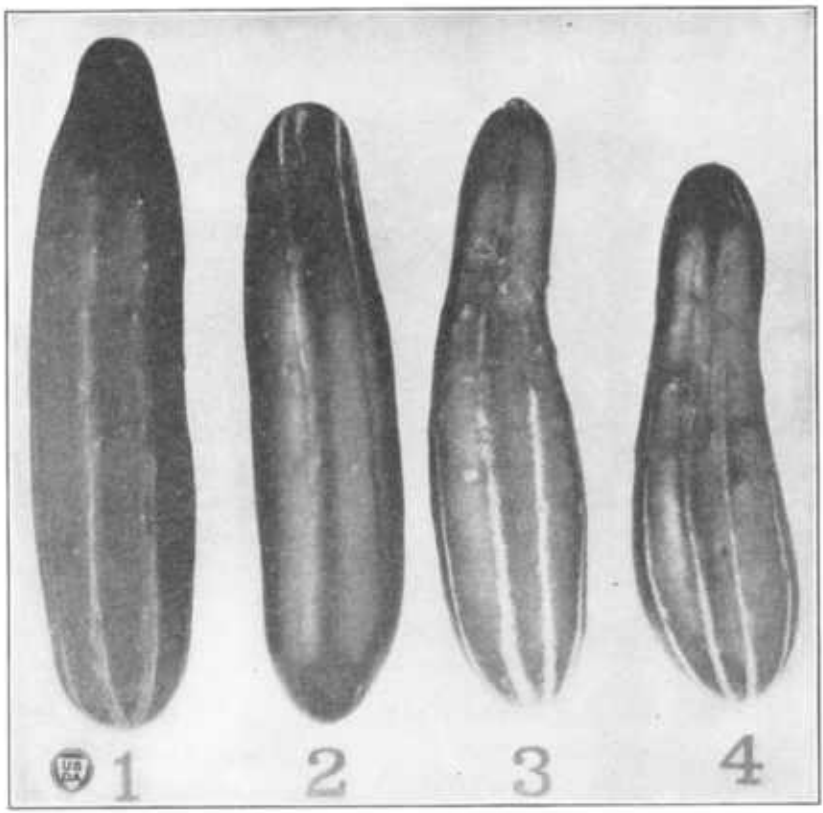

FIGURE 17.—Four grades of cucumbers into which the product of a large greenhouse range is divided. The best grades are packed in boxes, while the poorer grades are sold in hampers or in barrels. The size, shape, and color of the cucumbers are taken into account in grading.

tance or they may be several hundred miles away but readily accessible by fast express service. Some growers ship as many as 150 barrels of cucumbers a day during the height of the season, and it is necessary that proper marketing facilities be available to handle these large quantities. Much of the product is handled on a commission basis, but in some of the larger sections cooperative marketing associations are in existence, and these maintain in each of the larger distributing points an agent whose duty it is to distribute the crop to the best advantage.

YIELDS AND RETURNS

The yields depend upon the care and attention given the crop. Under favorable conditions from 30 to 60 cucumbers may be expected from each plant. As many as 100 to 120 cucumbers have often been gathered from a single plant. As a rule, heavier yields will be secured from spring-sown cucumbers than are had from a fall or winter crop. The price received varies greatly and may range from as low as 50 cents to as much as $2 per dozen. The higher prices are received for the best grades and for that portion of the crop produced at the season when there is the greatest demand for a high-class product. During the later portion of the season of the spring crop the price sometimes goes so low that it does not pay to continue picking and packing the cucumbers.

FIGURE 18.—Containers used at a large cucumber-growing plant for marketing the product.

No comprehensive statement can be made relative to the returns to be expected from a cucumber crop. It is safe to say that the grower who produces maximum yields of high-quality cucumbers will ordinarily make a satisfactory profit. Very high returns per acre of ground enclosed in greenhouses are essential, on account of the cost of houses and equipment and the heavy expenses necessary for fuel, labor, manure, fertilizer, packages, etc.

The cucumber is one of the most promising of the vegetable-forcing crops, but it can be successfully produced only by paying close attention to all the details of this highly specialized industry.

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